MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EPM1076 – INTRODUCTION TO MACHINES AND POWER SYSTEMS

(TE, RE)

14 MARCH 2020
9:00 AM - 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This booklet consists of 4 pages including cover pages with 4 questions only.
2. Attempt **ALL** questions given. All questions carry equal marks and distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary working **MUST** be shown.

Question 1

Open circuit test and short circuit test are performed on the primary side of a 20kVA, 4000/250V, 60Hz, single phase transformer to determine its equivalent circuit impedances. The tests results are tabulated in Table Q1.

Table Q1

Open circuit test	Short circuit test
$V_{oc} = 4000V$	$V_{sc} = 478V$
$I_{oc} = 0.24A$	$I_{sc} = 2.5A$
$P_{oc} = 400W$	$P_{sc} = 240W$

(a) Find the impedances of the approximate equivalent circuit referred to the primary side and sketch the circuit.

[13 marks]

(b) Based on calculation from part (a), determine the voltage regulation in percentage when supplying 250V to a full load at 0.8 lagging power factor.

[12 marks]

Question 2

(a) A three phase, 500MVA, 20.8kV, 4 poles, star-connected synchronous machine has negligible stator resistance and a synchronous reactance of 0.8Ω per phase at rated terminal voltage. The machine is operated as a generator connected to an infinite bus of 20.8kV.

(i) Sketch the per phase equivalent circuit of the synchronous machine.

[2 marks]

(ii) Calculate the excitation voltage per phase and power angle when the synchronous machine is delivering rated power at a power factor of 0.8 lagging.

[7 marks]

Continued ...

(b) A three phase, 440V, 60Hz, 6 poles, delta-connected induction motor has the following parameters referred to the stator.

Stator resistance, $R_s = 0.1\Omega$
Stator reactance, $X_s = 0.7\Omega$
Magnetization reactance, $X_m = 35\Omega$
Rotor resistance, $R'_R = 0.3\Omega$
Rotor reactance, $X'_R = 0.7\Omega$

The rotor is running at 960rpm and assume negligible core resistance. Using approximate equivalent circuit model, calculate the:

(i) slip of motor,

[3 marks]

(ii) per phase stator current,

[8 marks]

(iii)input power factor, and

[2 marks]

(iv)total input electrical power.

[3 marks]

Question 3

(a) Describe the importance of single line diagram.

[3 marks]

(b) The single line diagram of a three phase power system is shown in Figure Q3. Select a common base of 80MVA and 22kV on the generator side. Draw an impedance diagram with all impedances marked in per unit.

[22 marks]

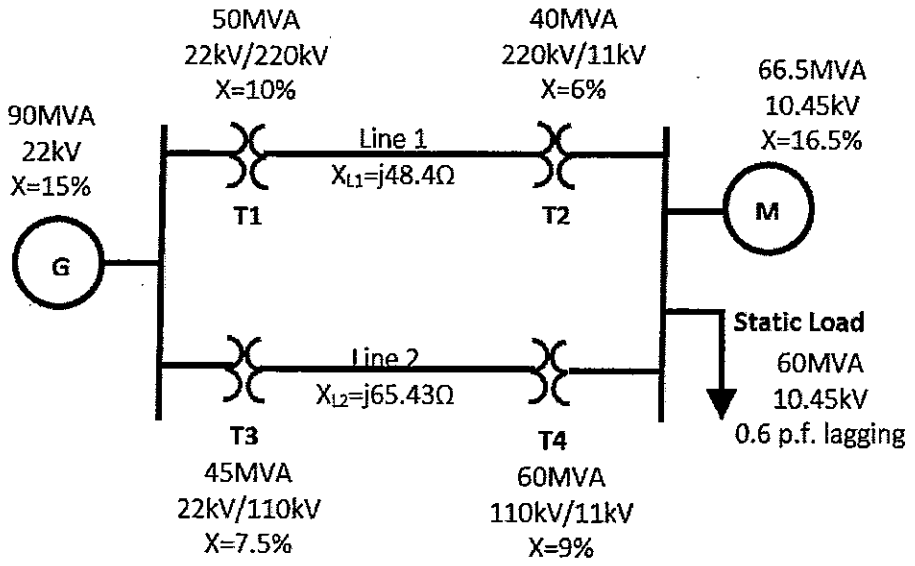

Figure Q3

Continued ...

Question 4

An 11kV, single phase system is protected by a scheme using IDMT relays as shown in Figure Q4. The circuit breakers CB1 and CB2 are associated with IDMT relays 1 and 2 through the Current Transformers (CT) with current ratios as mentioned in the figure. If maximum fault current of 7000A is occurring at Bus C, protection scheme must clear it in 2.25s. Using relay characteristic as shown in Table Q4, solve the following:

(a) Find the plug setting multiplier of Relay 2 at plug setting of 100% and 50%.

[8 marks]

(b) Determine the time multiplier setting of each IDMT relay to afford effective discrimination of 0.4s at plug setting of 50% for both relays.

[17 marks]

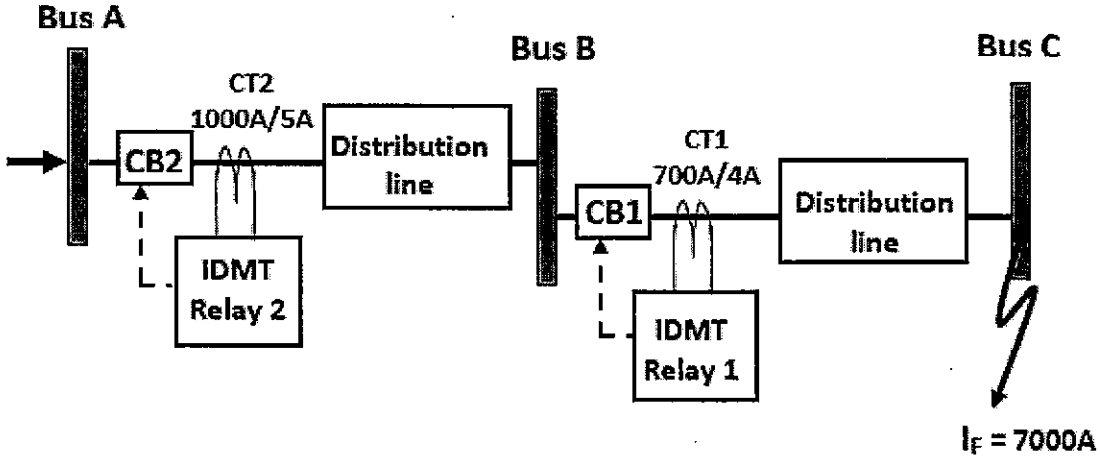

Figure Q4

Table Q4

PSM	2	4	6	7	8	10	14	18	20
T (s)	10	5	4	3.5	3	2.8	2.4	2.2	2.0

*Actual operating time of relay = T X TMS

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